

1 lower section 20. The reaction chamber has outer  
2 diameters ranging from  $\frac{1}{4}$  inch to 4 inches.

3 An axially extending radiant burner 7 is  
4 vertically disposed along the central axis of the  
5 helical coil section 20 of the tubular reaction  
6 conduit. The radiant burner is supported by a burner  
7 gas conduit 12 that conveys a mixture of fuel and  
8 oxidant from the inlet means 8 to the radiant burner.  
9 In this embodiment, the radiant burner 7 comprises a  
10 gas permeable metal fiber zone 14 that subtends the  
11 entire circumference of the radiant burner. Fuel and  
12 oxidant pass through the permeable metal fiber zone 14  
13 where they are ignited on the surface, thereby  
14 combusting and releasing heat to form an incandescent  
15 zone that radiates energy in a predominantly uniform  
16 radial direction. The helical tubular reaction chamber  
17 and catalyst therein are sized for creation of mass  
18 velocities ranging from 400 lb/ft<sup>2</sup>/h to 1500 lb/ft<sup>2</sup>/h.  
19 The catalyst in the helical tubular reaction chamber  
20 has average catalyst particle diameters ranging from  $\frac{1}{4}$   
21 to 1 inch for producing gas pressure drops ranging from  
22 1 psi to 8 psi during flow through the reaction  
23 chamber. The helical tubular reaction chamber has gas  
24 exit end temperature ranging from 1150°F to 1400°F,  
25 when heated by said radiant burner, in operation. The  
26 helical tubular reaction chamber has maximum tube wall

1 temperatures ranging from 1300°F to 1600°F, when heated  
2 by said radiant burner, in operation. The helical  
3 tubular reaction chamber has average heat fluxes  
4 ranging from 3,000 btu/ft<sup>2</sup>/h to 10,000 btu/ft<sup>2</sup>/h, when  
5 heated by said radiant burner in operation. The  
6 helical tubular reaction chamber is sized to have  
7 capacity to generate hydrogen plus carbon monoxide  
8 product in volumetric quantities ranging from 50 SCFH  
9 to between 100 and 1500 SCFH. The radiant burner  
10 comprises a supported metal fiber material consisting  
11 essentially of an alloy containing principally iron,  
12 chromium, and aluminum and smaller quantities of  
13 yttrium, silicon, and manganese, said alloy having  
14 extended life at operating temperatures up to 2000°F.  
15 The radiant burner has surface temperatures ranging  
16 between 1500°F and 1900°F, in operation. The radiant  
17 burner has an operating combustion intensity typically  
18 ranging from 150,000 btu/ft<sup>2</sup>/h to 350,000 btu/ft<sup>2</sup>/hr,  
19 wherein the combustion intensity is defined as the  
20 higher heating value of the fuel combusted divided by  
21 the permeable radiant burner surface area. The radiant  
22 burner has an operating excess air ratio typically  
23 ranging from 30% to 100%, wherein the excess air ratio  
24 is defined as percent combustion air in excess of the  
25 stoichiometric amount required for complete combustion  
26 of the burner fuel. The helical coil has free area in

1 the range 50% to 75%, wherein the free area is defined  
2 as the ratio of the free area between successive coil  
3 turns and the cylinder that bisects the helical coil  
4 circle.

5 In Figs. 1, 3 and 4, a gas conditioning  
6 system 101 and fuel cells 100 to receive hydrogen are  
7 in operative communication with reactor outlets 3.

8 Fig. 5 depicts yet another embodiment of the  
9 present invention. In this embodiment shown  
10 schematically the reaction chamber 116 is defined by  
11 the annular space between an outer conduit 131 and an  
12 inner conduit 132. The reactant gases enter the  
13 reaction chamber through inlet means 112, and pass  
14 through catalyst bed at 116 and then to space 134 at  
15 the inlet of the inner conduit 132. The reactant gases  
16 exit the inner conduit space through exit means 113.  
17 The reactant gases passing through the inner conduit  
18 132 transfer heat to the reactant gases contained in  
19 the reaction chamber 116 to beneficially recuperate  
20 heat from the endothermic reaction.

21 An axially extending radiant burner 107 is  
22 vertically disposed within a combustion chamber 104.  
23 The radiant burner is oriented in parallel with the  
24 longitudinal extent of the tubular reaction conduit.  
25 If a multiplicity of such tubular reaction conduits are  
26 used, they can be oriented concentrically around a